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## AIRS L1C Frequency Calibration

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- Update from last October Science Team Meeting
- Cross-correlation technique works well for several modules, **except** over poles.
- Fall 2008: calibrated whole mission using M12 and cloud-cleared radiances
- M12 failed, to some degree, over poles (only Q-branch had contrast). Did not use internal QA.
- **This presentation:** Calibrated whole mission using M3 (water,  $1400\text{ cm}^{-1}$ ) *and* M10 ( $\text{CO}_2$ ,  $750\text{ cm}^{-1}$ ), retained and used internal QA (B(T) contrast).
- Goal: Make frequency calibration a “non-issue” for AIRS climate applications.

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- Use a cross-correlation technique on M3 and M10 for  $\nu$  calibration
- Cross-correlate L2CC radiances with Calc radiances. Calcs done using AIRS L2 retrievals.
- Careful selection of channels
- One  $\nu$  calibration per granule.
- Units: using “micron” shift in focal plane.
  - Shifts referred to as “yoffsets”
  - 1 micron  $\sim$  1% of an SRF FWHM
  - Yoffsets measured relative to TVAC values, generally had  $\sim$  -14  $\mu\text{m}$  shift at launch, with about 1  $\mu\text{m}$  during rest of mission.

# $\Delta B(T)$ for a $dx = 1 \mu\text{m}$

$1\mu\text{m}$  Equal to Mission Shift, Orbital  $\sim 0.4 \mu\text{m}$

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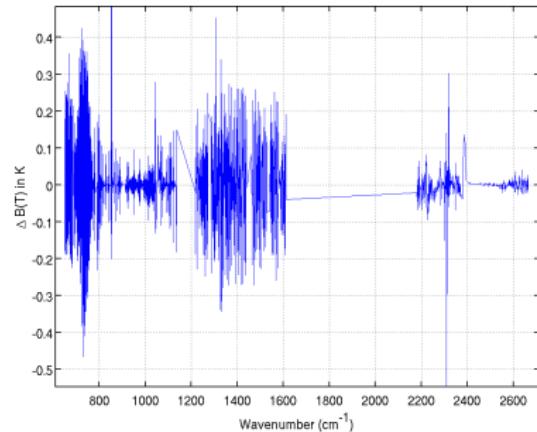
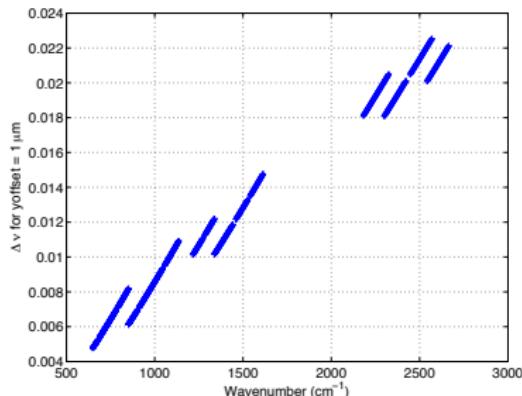
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# Frequency Calibration Model

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Raw  $\nu$  (Yoffset) calibrations were binned by 2 deg. in orbit phase, giving 180 data sets, each one is fit to the following expression:

$$y(t) = y_o - b_1 \exp(-t/\tau) + \sum_{i=1}^3 [a_i \sin(2\pi t + \phi_i)]$$

- **Fast time behavior** is orbit phase (latitude), parameterized by 180 values for  $b_1$ ,  $\tau$ , three  $a_i$  harmonic terms, and their phases,  $\phi_i$ .
- **Slow time behavior** is due to seasonal and slower effects. Data first averaged over 16 day time periods for fits to the above equation.

# M3 Raw Calibration (per granule)

With, and without B(T) Contrast Filter

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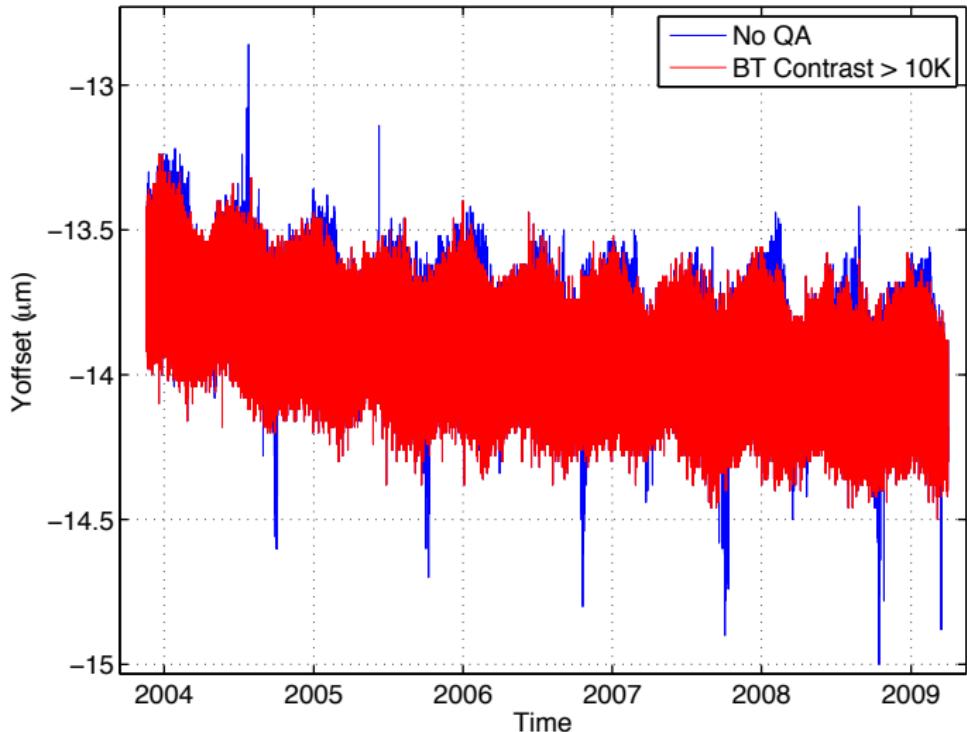
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# M10 Observations (per granule)

With, and without B(T) Contrast Filter

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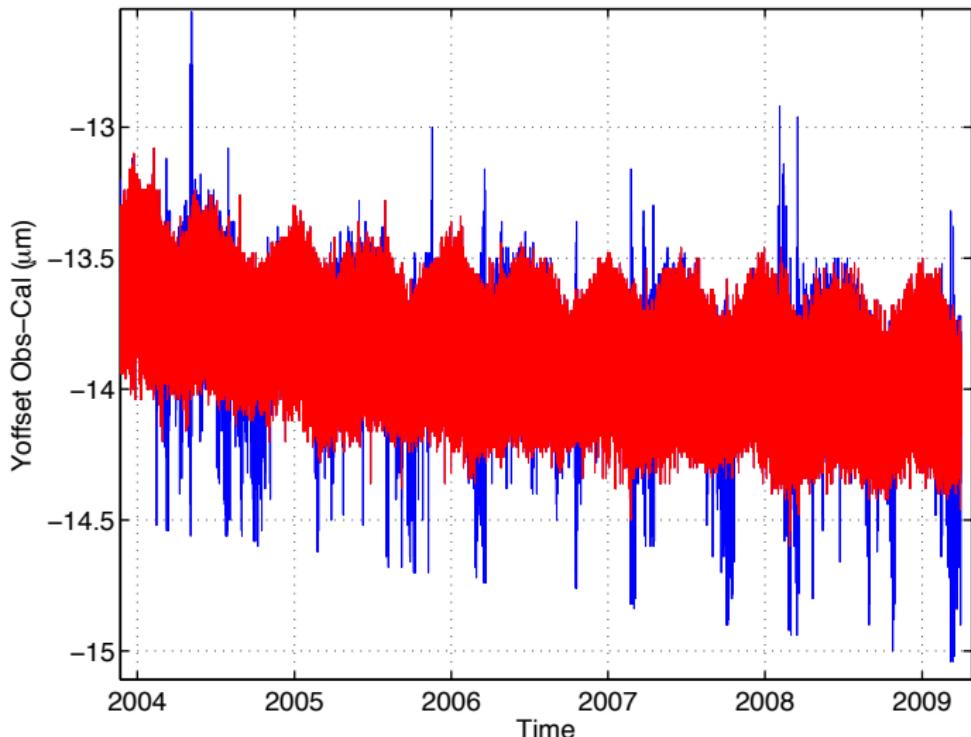
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OLD  $\nu$  Calibration

Binned by 2 deg in latitude, 16 days in time

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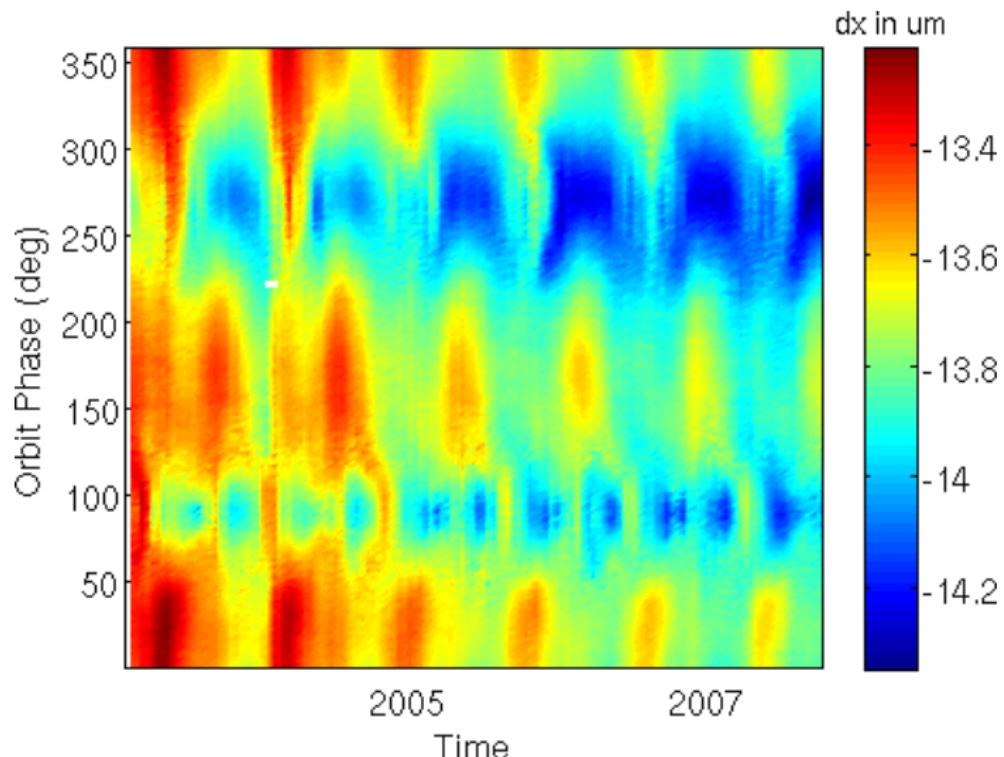
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# M3 Yoffset vs Orbit Phase

Binned by 2 deg in latitude, 16 days in time

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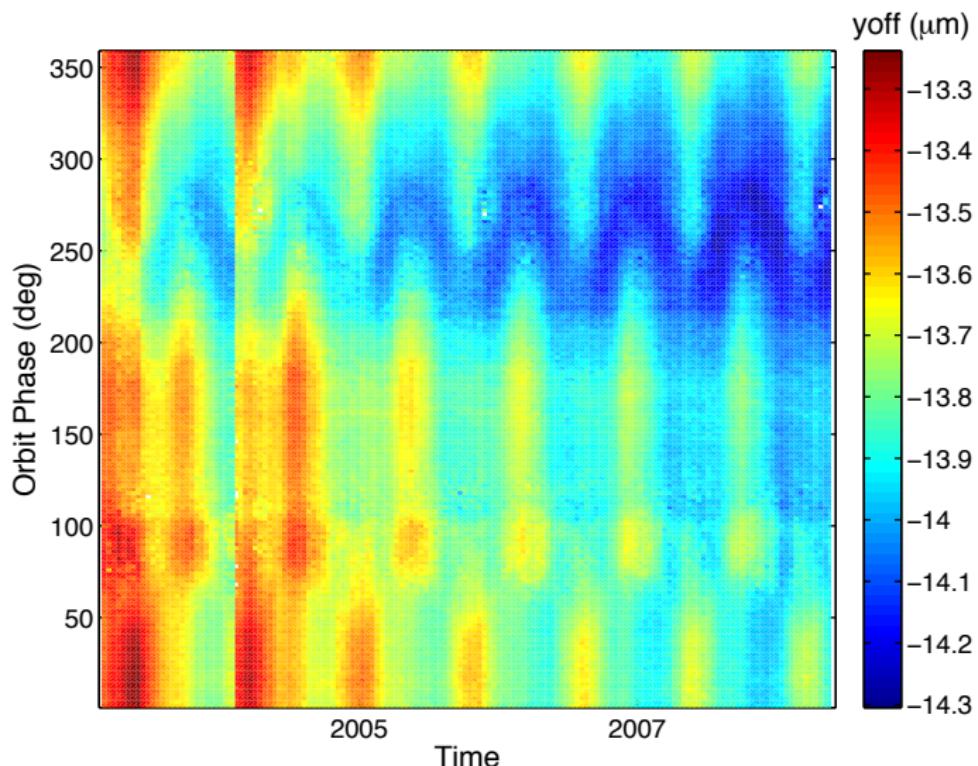
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# Tropical M3 Calibration

Further binning to  $\pm 30$  deg

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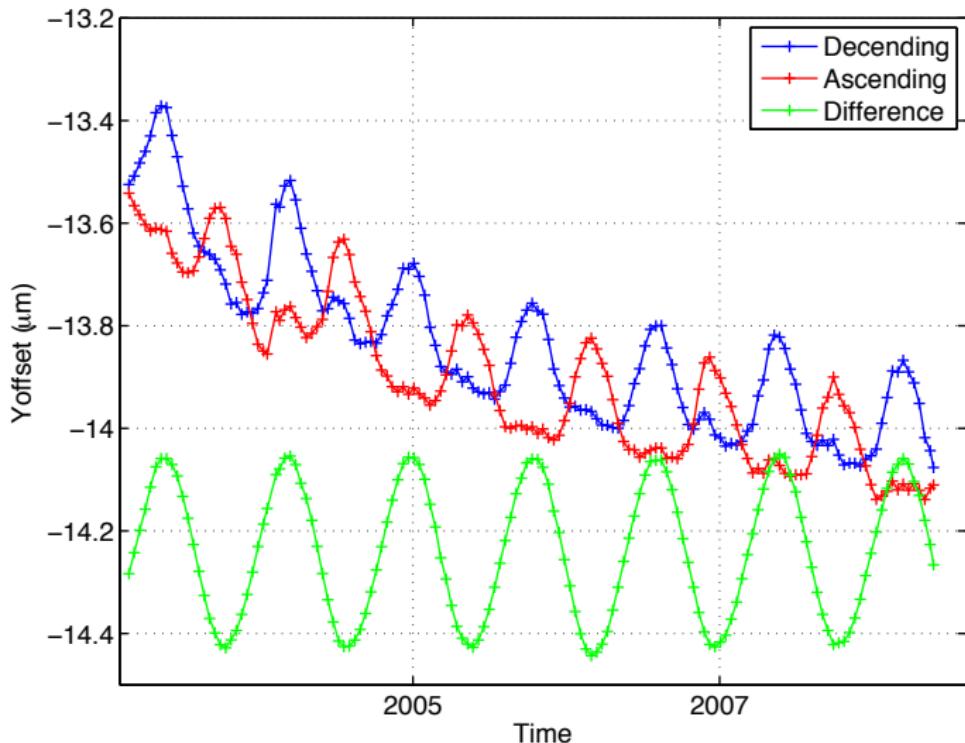
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# Polar M3 Calibration

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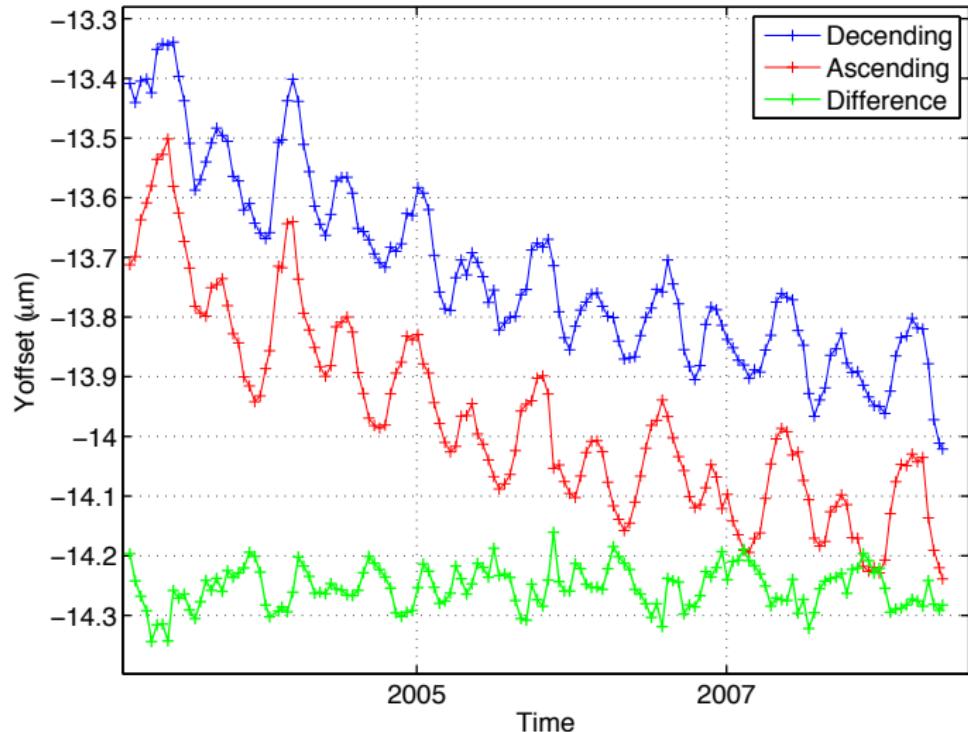
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# Yoffset versus Latitude

Averaged over 5 Years

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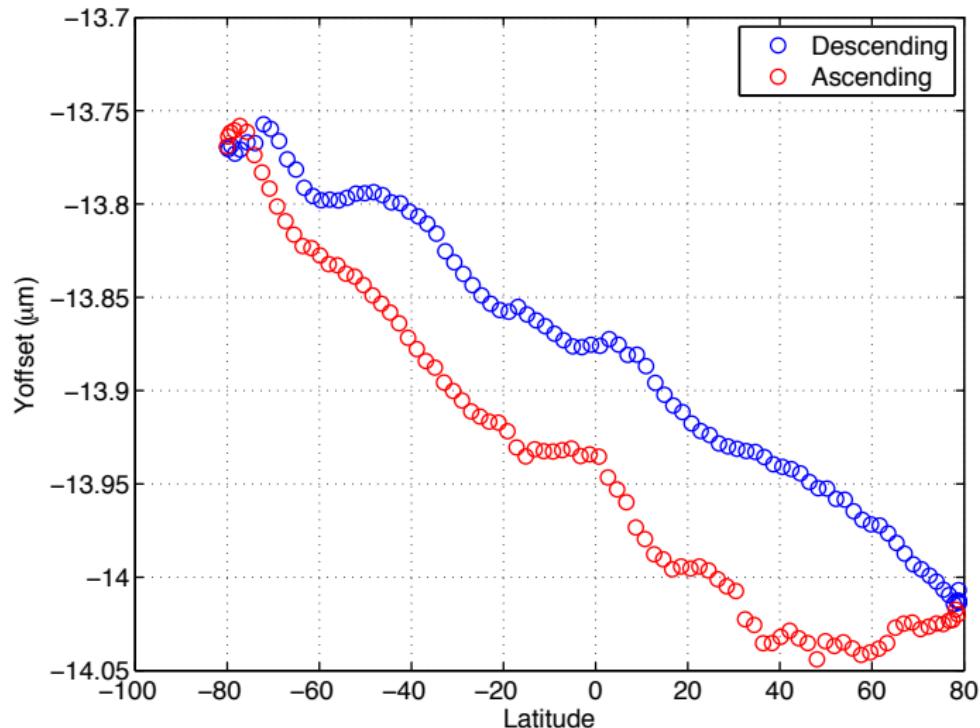
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# M3 Monthly Avg. Yoffset vs Orbit Phase

Back to raw binned data but aggregated by month (for all years).

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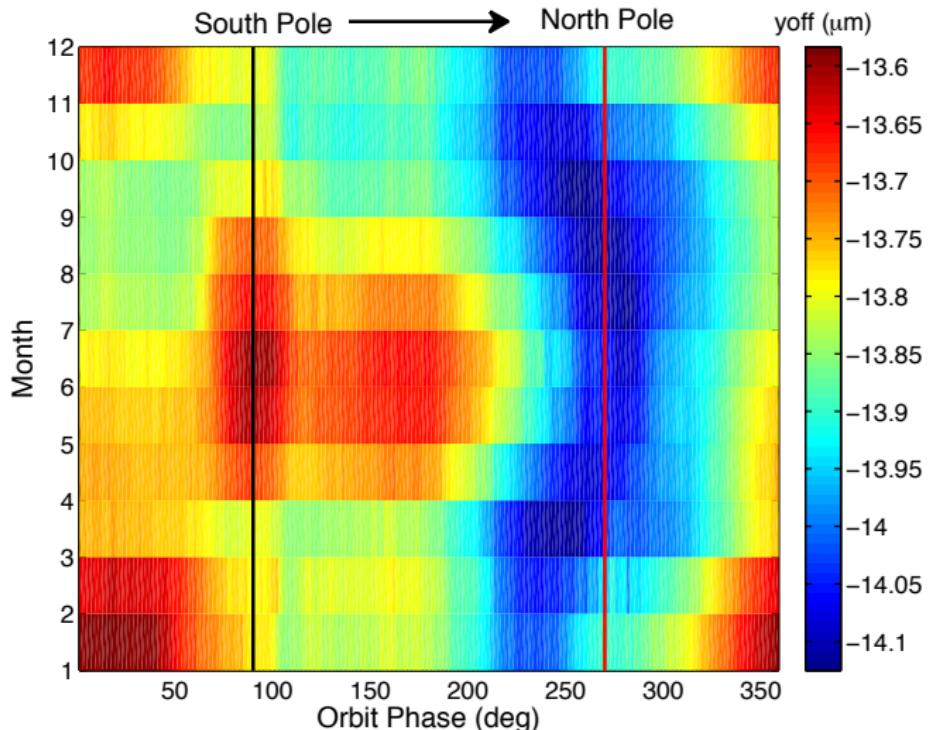
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Will now examine reasonableness of the fitted parameters.  
Reminder:

$$y(t) = y_0 - b_1 \exp(-t/\tau) + \sum_{i=1}^3 [a_i \sin(2\pi t + \phi_i)]$$

# Amplitude of Sinusoidal Terms

These are the  $a_1$ ,  $a_2$ ,  $a_3$  terms for each 2-deg bin of orbit phase.

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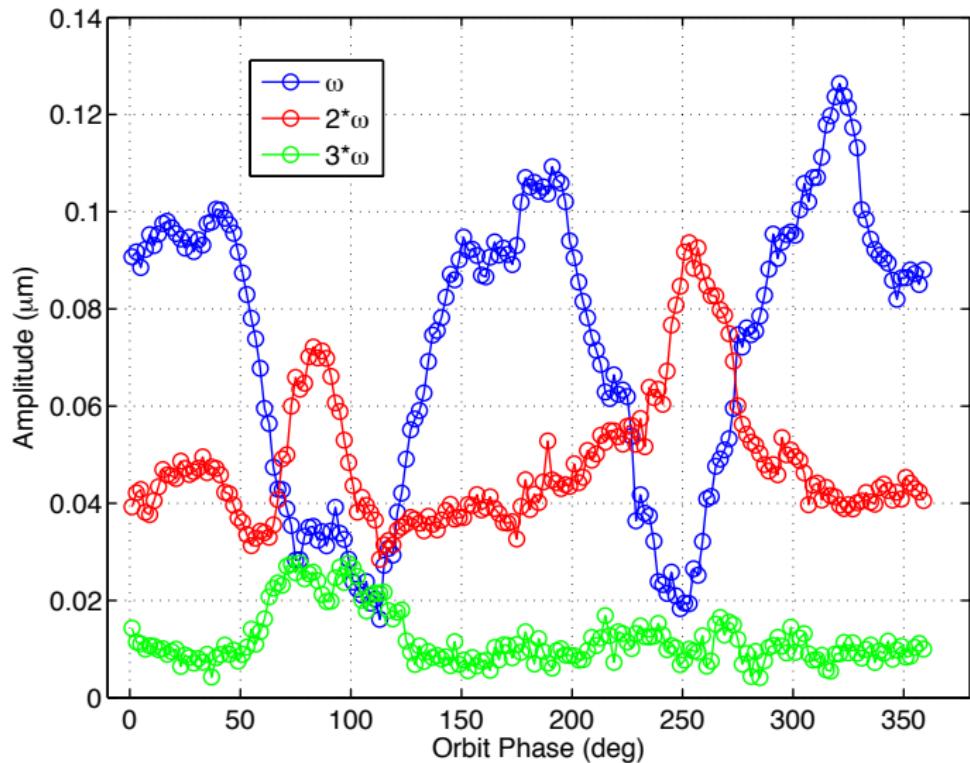
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# Yoffset Decay Time Constant vs Latitude

$\tau$  for both M3 and M10 versus Latitude

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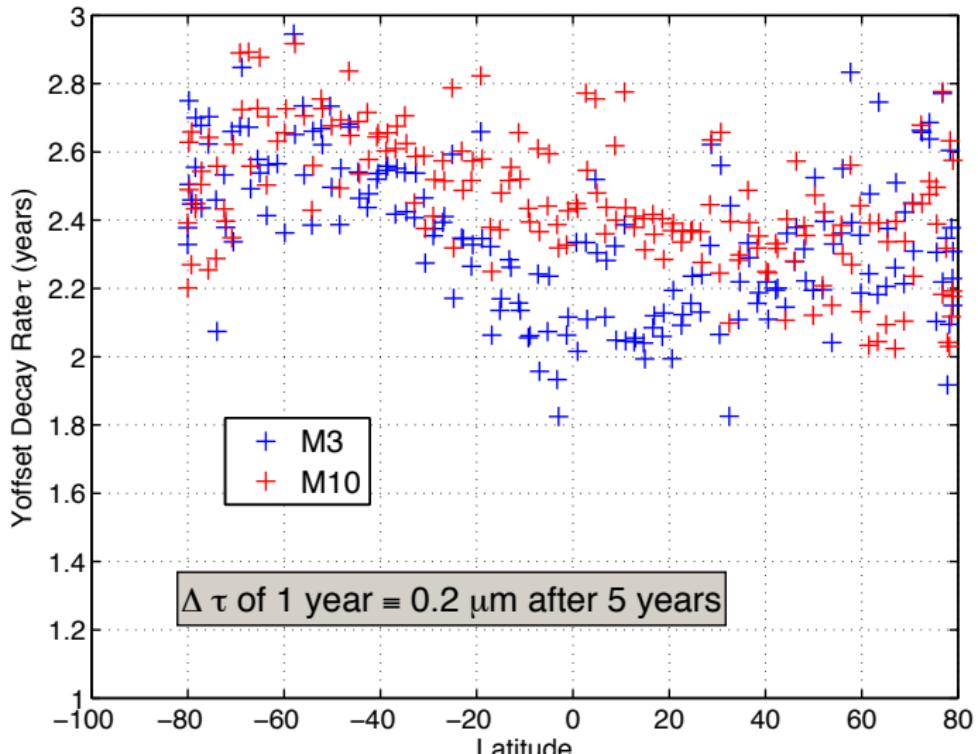
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Yoffset Decay Amplitude vs Latitude ( $b_1$  Terms)

$$y(t) = y_o - b_1 \exp(-t/\tau) + \sum_{i=1}^3 [a_i \sin(2\pi t + \phi_i)]$$

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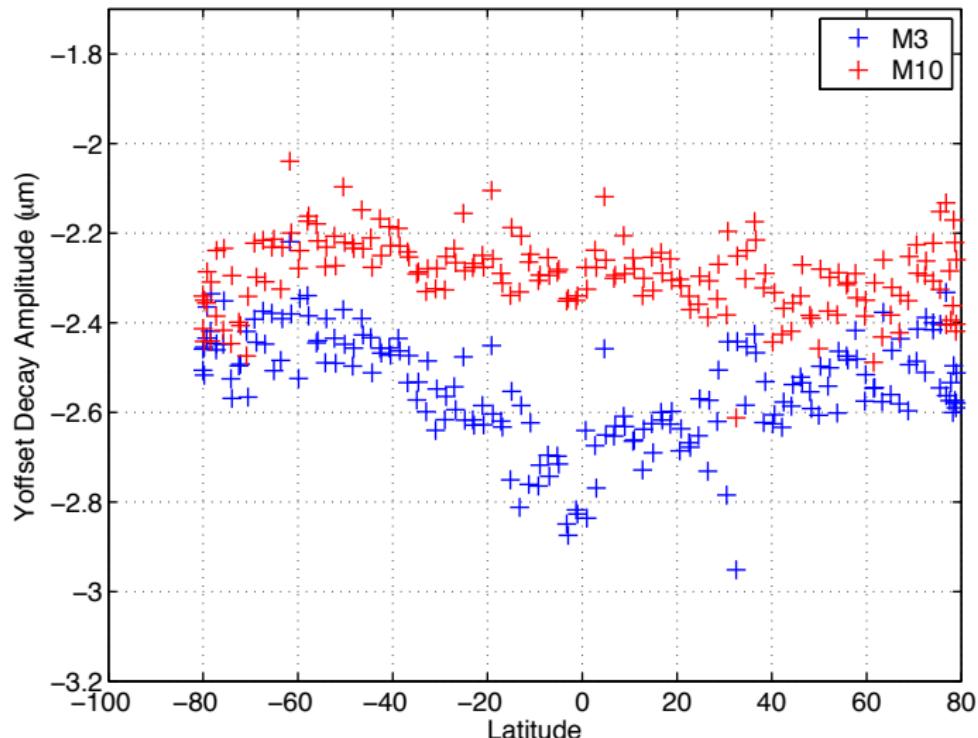
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# Obs - Fitted Calibration, M3

Mission through 2009+

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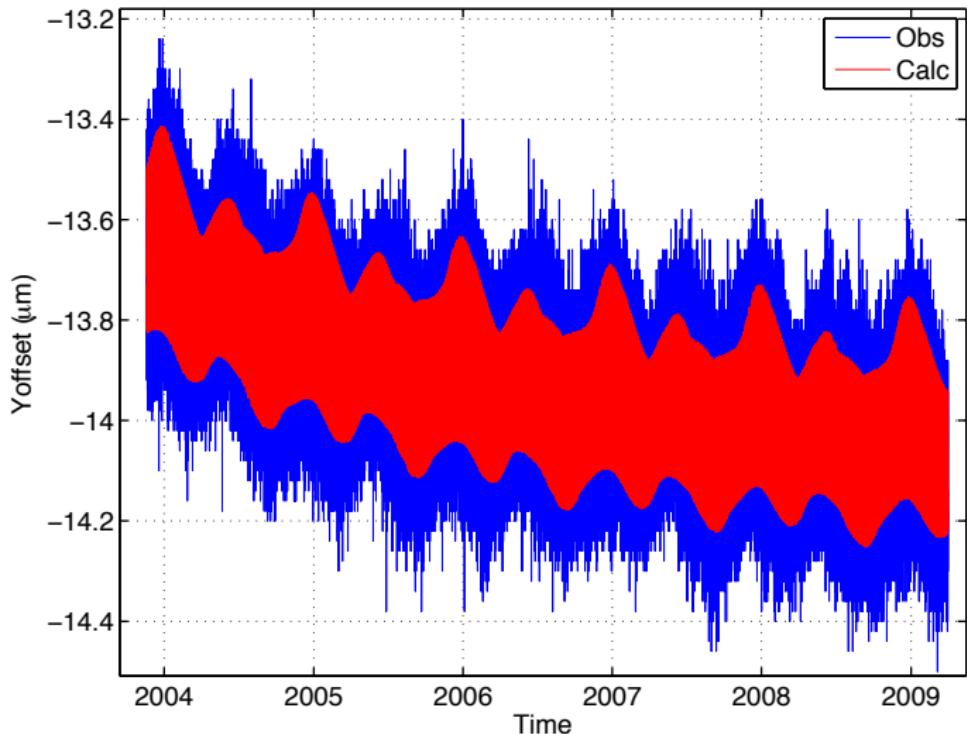
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# Obs - Fitted Calibration, M3: 2007

1-year

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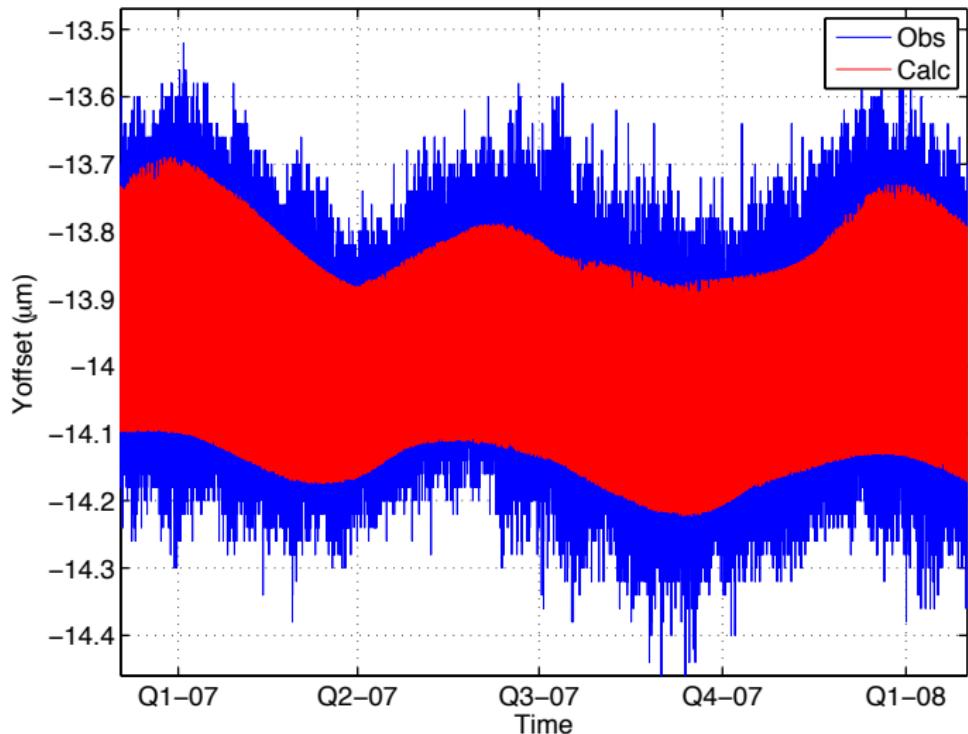
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# Obs - Fitted Calibration, M3: Jan. 08, 2007

1-day

ASL

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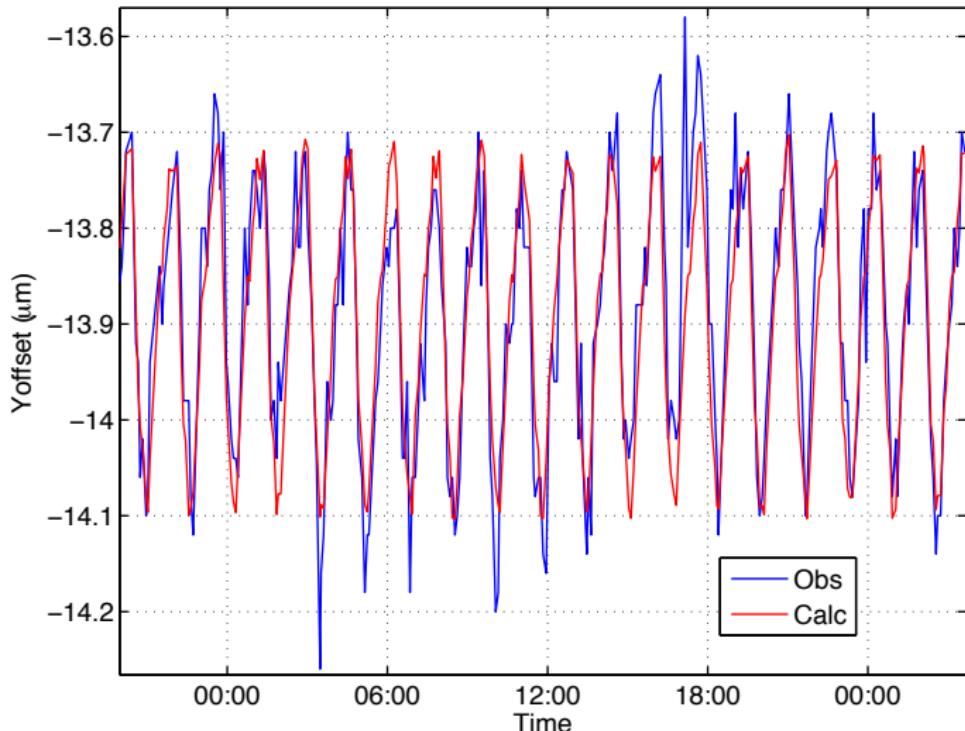
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# Histogram of M3 Obs-Calc Good FOVs

Errors are Gaussian; Bias = 0.00  $\mu\text{m}$ , Std = 0.06  $\mu\text{m}$

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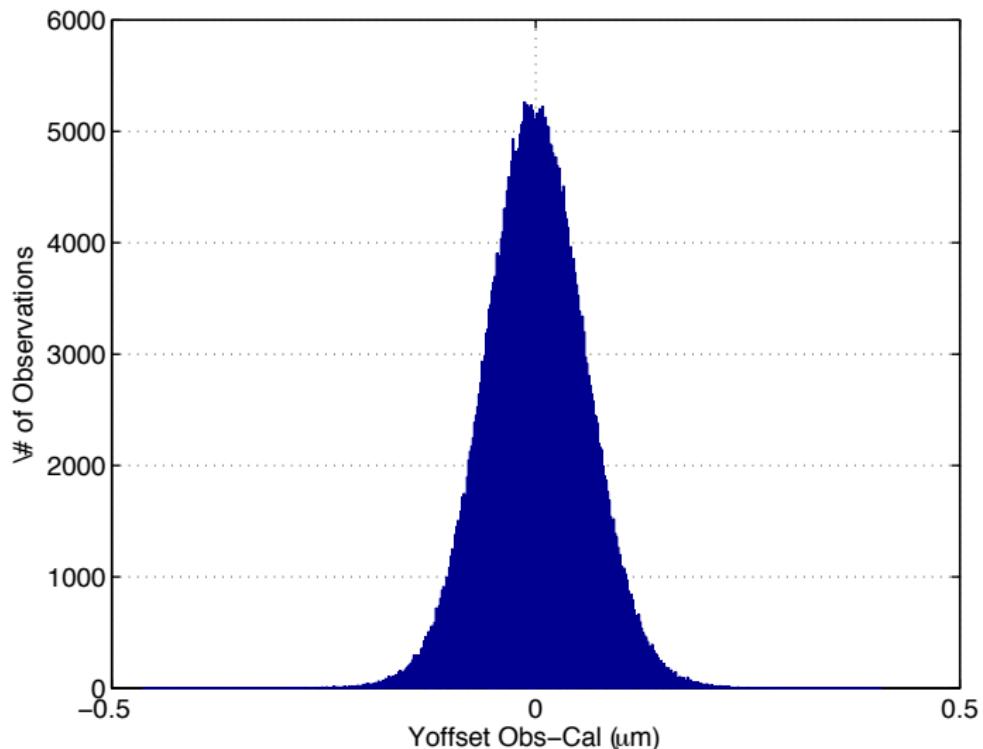
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# Histogram of M3 Obs-Calc for Outlier FOVs

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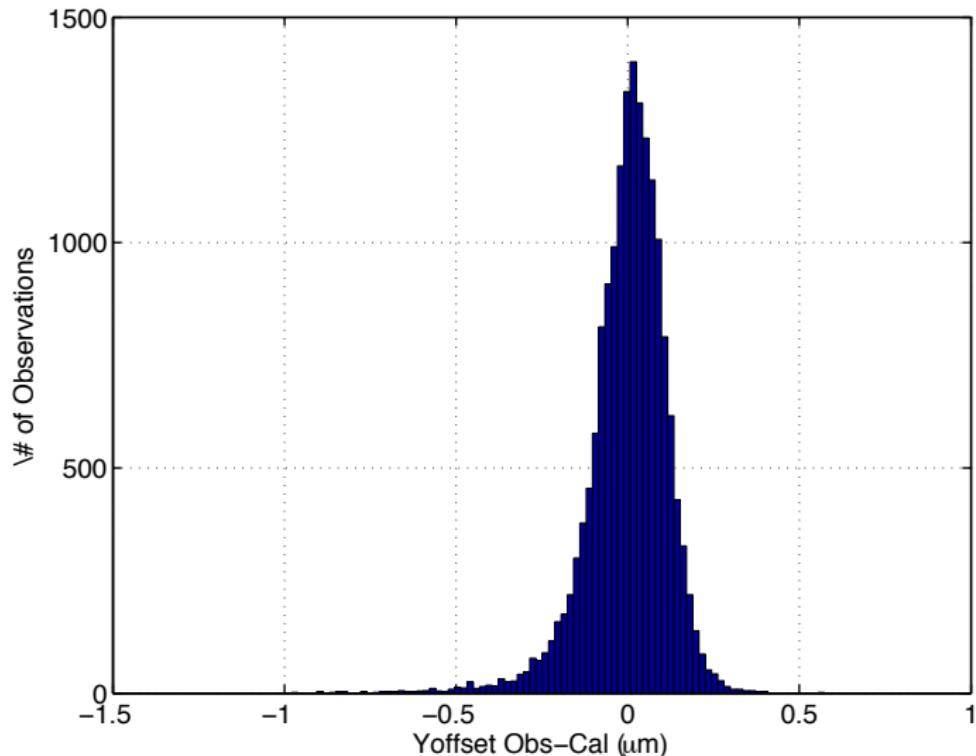
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# Difference Between M3 and M10:

## Raw Data and Fit

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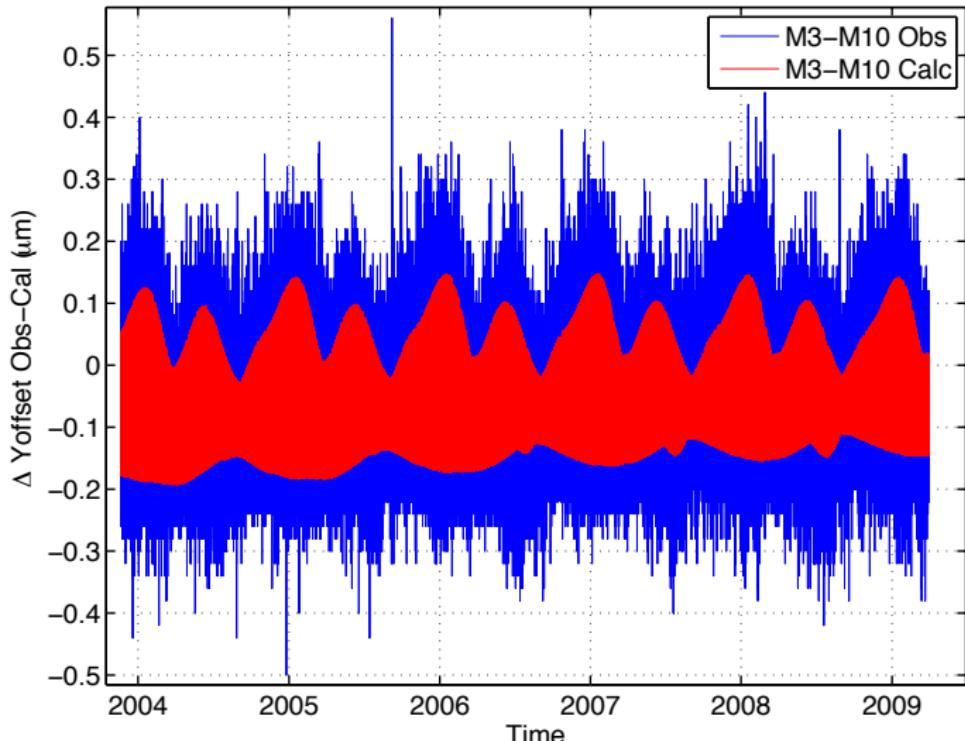
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# Histogram of M3 minus M10 Obs

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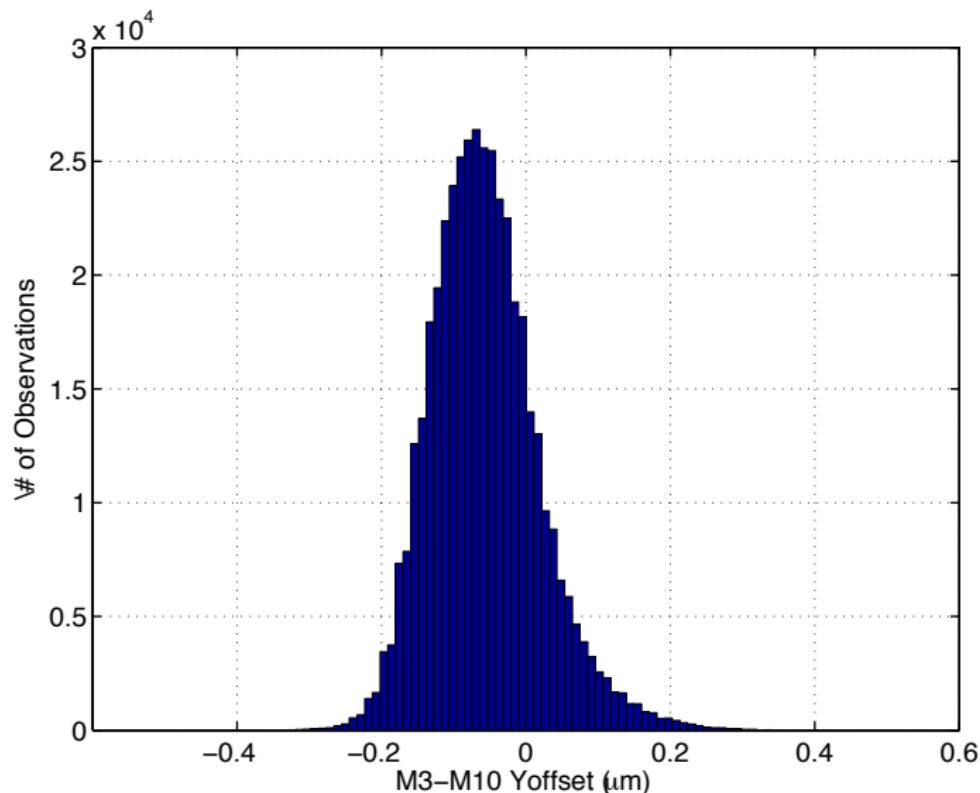
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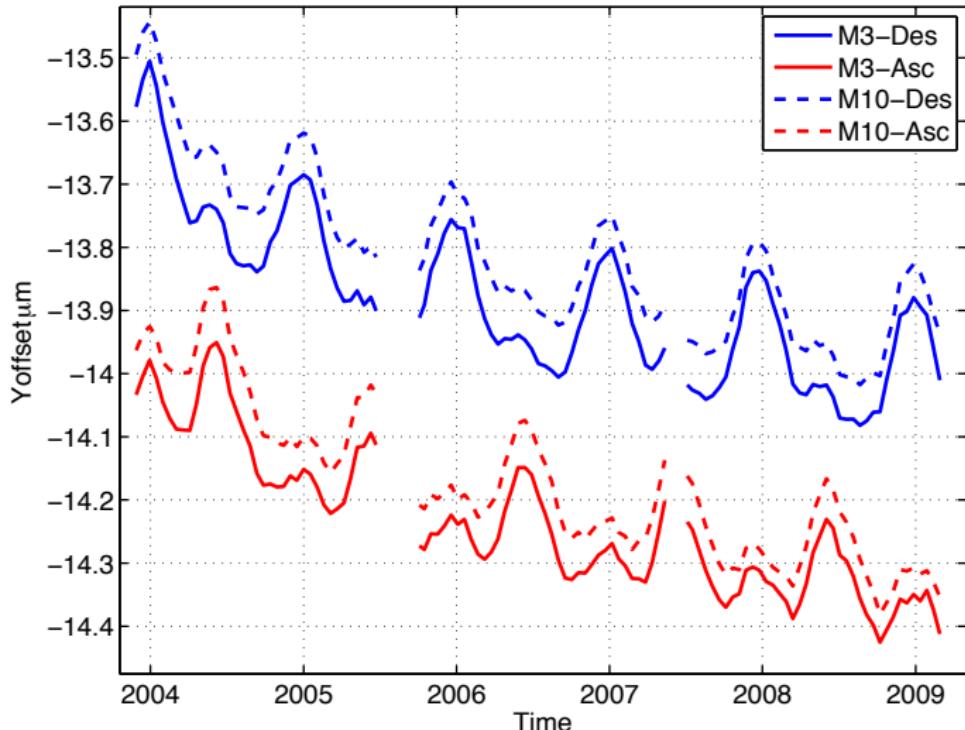
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## Variation of M3 and M10 Yoffset: Tropics

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# Other Arrays

Use tropics for offsets

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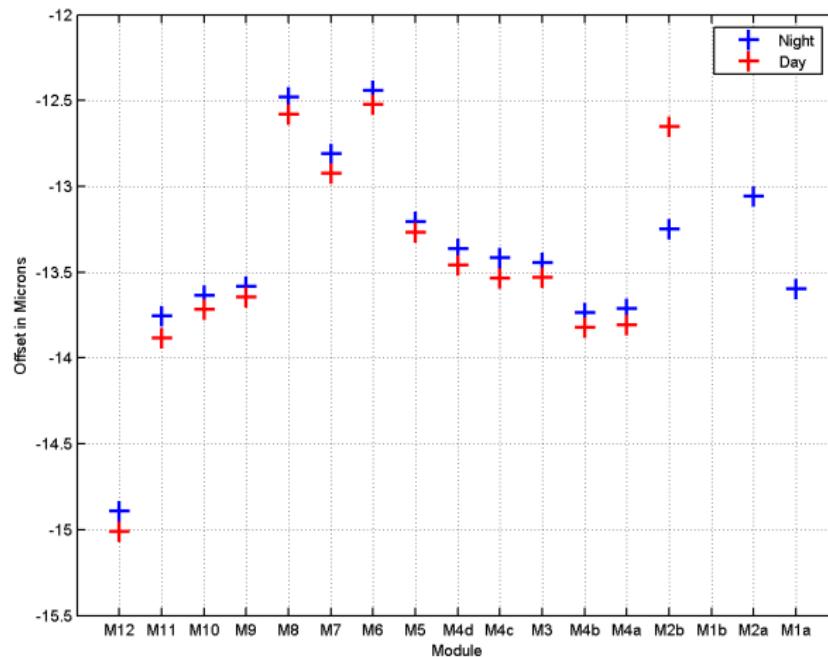
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# Conclusions

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- M3 appears to be the best module for frequency calibration
- Behavior is somewhat complicated, but reasonable
- Use tropics to determine static offset between M3 and other modules. Higher errors in some modules reflect lower requirement for knowledge of the module frequency.
- Some concern that some modules may move differently. Will evaluate fitting parameters in tropics for almost all modules.
- Almost ready for V6 implementation.  $\tau$  term should predict future drifts unless instrument is stressed.